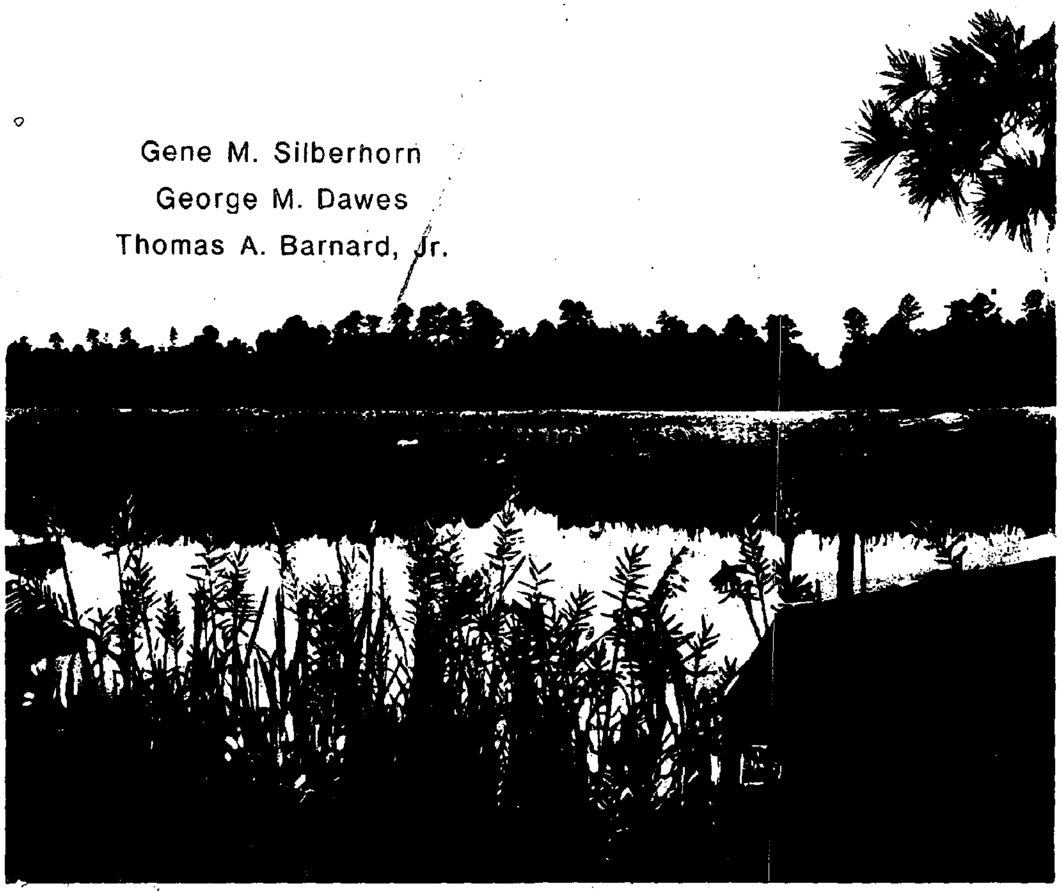
COASTAL WETLANDS OF VIRGINIA

Interim Report No. 3

GUIDELINES FOR ACTIVITIES AFFECTING VIRGINIA WETLANDS

Gene M. Silberhorn
George M. Dawes
Thomas A. Barnard, Jr.



Special Report in Applied Marine Science and Ocean Engineering No. 46

Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

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William J. Hargis, Jr.
Director

June 1974

PREFACE

In response to the Legislature's directive "to make a study and report on all marsh and wetlands in the state" (House Joint Resolution No. 69, 1968) in December, 1969, the Virginia Institute of Marine Science published its first interim report on the coastal wetlands of Virginia (Wass and Wright, 1969). The report emphasized the ecology of wetland areas, their values to the marine environment, their values to man, and man's relationships with wetlands. More importantly, the report presented recommendations for a legal definition of wetlands and for the regulation of activities detrimental to wetlands. Some specific scientific research needs were also cited.

In March, 1972, the Virginia Legislature enacted the Wetlands Act of 1972 which became effective on 1 July 1972 (Code of Virginia, 62.1). While establishing controls over Virginia's wetlands, as recommended in the first interim report, the act also assigned additional responsibilities to the Virginia Institute of Marine Science. In July, 1972, the Virginia Institute of Marine Science published a second interim report on coastal wetlands (Marcellus, 1972). Essentially a progress report, the second report further identified research needs necessary for effective management of wetlands.

This third report primarily responds to the Legislature's requirement that the Virginia Institute of Marine Science provide advice and assistance to the Virginia Marine Resources Commission in the development of guidelines for evaluating wetlands by type and in identifying consequences of use of wetlands. This report also identifies continuing research needs. The research needs and guidelines set forth herein are based upon the best knowledge of, and experience with, Virginia wetlands available at this time. VIMS will modify and upgrade the guidelines and research needs as it becomes possible and necessary.

ACKNOWLEDGMENTS

Much of the research upon which this paper is based was initiated by Dr. Kenneth L. Marcellus, formerly of this Institute, who also obtained considerable data reported herein. The authors express their gratitude for his guidance and contributions and their regret that he was unable to participate in the final preparation of this report.

Appreciation is also extended to Drs. William J. Hargis, Jr., W. Jackson Davis, Michael E. Bender, Robert J. Byrne, Marvin L. Wass, Messrs. James L. Mercer, Gary Anderson and Carl H. Hobbs, all of the Virginia Institute of Marine Science, for their constructive review and suggestions which have added greatly to the interdisciplinary nature of the report.

We wish also to thank the Honorable James E. Douglas, Jr., Commissioner of the Virginia Marine Resources Commission, Mrs. Joan C. Skeppstrom and Mr. James L. Sisson, Jr., Associate Members of the Virginia Marine Resources Commission, for their review of draft papers and their participation in joint conferences which have helped shape the direction of the final report.

The authors have virtual daily contact with members of local wetlands boards who, along with various staff and members of the Virginia Marine Resources Commission, will be the ultimate users of the report. We are particularly grateful for the contributions of the wetlands board members who have patiently outlined their needs for management information and whose suggestions have strongly influenced the report.

There are many State and Federal agencies who have interests in applications for permits to alter the Virginia shoreline. The authors are appreciative of the responses received from the Virginia Commission on Game and Inland Fisheries, the State Division of Planning and Community Affairs, the State Bureau of Shellfish Sanitation, the Virginia Water Control Board, Region III of the U. S. Environmental Protection Agency, the Annapolis office of the U. S. Fish and Wildlife Service, and the Baltimore and Norfolk Districts of the U. S. Army Corps of Engineers.

Much of the research upon which this report is based was supported by the Research Applied to National Needs (RANN) Program of the National Science Foundation through the Chesapeake Research Consortium, Inc. The authors are grateful for this practical support.

Finally, we thank Mrs. Beverly Bennett, Mrs. Judy Hudgins and Miss Rhonda Rupe for their excellent support in typing many draft papers and the final manuscript.

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SECTION I

INTRODUCTION

Article XI of the Constitution of Virginia establishes a policy for the conservation, development and utilization of natural resources. In furtherance of this aim the Virginia Wetlands Act of 1972 declared it to be "the public policy of this Commonwealth to preserve the wetlands and to prevent their despoliation and destruction and to accommodate necessary economic development in a manner consistent with wetlands preservation." (Code of Virginia, 62.1-13.1).

There are many types of ecological systems in the coastal zone. Below the low tide limits are found the vast, productive submerged lands which are vitally important to fish and shellfish as spawning, nursery and feeding grounds. This area is vegetated by aquatic perennials and species of benthic algae. Uses of this bottomland are controlled by the Commonwealth, with the Virginia Marine Resources Commission serving as the management agency (Code of Virginia, 62.1-3). Above the low tide limits and extending up to about mean sea level are found mud or sand flats which are bare of plants readily discernable to laymen. While appearing to be lifeless, these flats provide important habitat for crabs, clams, oysters, worms and other estuarine organisms. Large populations of algae, bacteria, fungi and microorganisms also inhabit this area forming complex interwoven communities.

Above the sand and mud flats, vegetation occurs which is tolerant to wet soils as well as periodic flooding. The plants in this area vary in accordance with salinity, wave action, frequency and duration of tidal flooding, elevation and soil composition. These lands, usually known as coastal marshlands, are valuable sources of energy in the aquatic system since the tons of plant material produced per acre-year are the basis of an important estuarine food web. In addition, ninety to ninety-five percent of the commercial and sport fishes landed in Virginia waters are dependent on marshes for food and/or habitat at some stage in their life-cycles. Marshes are also habitat for many other species of estuarine life, particularly waterfowl. They also aid man in protecting fastlands from erosion, maintaining water quality and buffering coastal flooding and sea level rise (Redfield, 1972). These are some of the reasons why wetlands are to be conserved and managed. For management purposes, the wetlands are defined as "all land lying between and contiguous to mean low water and an elevation above mean low water equal to the factor 1.5 times the mean tide range....." and upon which grow one or more specific kinds of vegetation (Virginia Code, 62.1-13.2(f)). The definition was based on knowledge developed by many ecologists and on both biological and physical considerations derived from the research conducted by the Virginia Institute of Marine Science assisted by the Virginia Marine Resources Commission (Marcellus, 1972).

Many types of wetlands are encompassed by the definition established by the Wetlands Act. Each has characteristic environmental values which are based on its chemical, biological and physical properties. Intelligent wetlands management requires identification of marsh values and their relation to the impacts of man's uses. This also is recognized in the Wetlands Act, which requires that the Virginia Marine Resources Commission shall, with the advice and assistance of the Virginia Institute of Marine Science, "from time to time promulgate guidelines which scientifically evaluate wetlands by type and which set forth the consequences of use of these wetlands types" (Code of Virginia, 62.1-13.4).

It is the primary purpose of this work to fulfill the legislative charges and mandate mentioned above. The secondary purpose is to suggest means by which damaging consequences of wetlands use may be lessened so that marshes may continue to contribute to the public good and necessary development may be accomplished in a manner consistent with wetlands preservation (Virginia Code, 62.1-13.1). Thirdly, the status of wetlands knowledge is reviewed and weaknesses and gaps identified. After accomplishing this purpose, appropriate questions are framed and research needs are presented.

SECTION II

WETLANDS TYPES AND PROPERTIES

To pursue the intent of the Wetlands Act, a typing and evaluating system must be established that is capable of being put to practical field use by boards or commissions who for the most part do not have comprehensive training in wetlands ecology. In meeting this objective, it is the judgment of the Virginia Institute of Marine Science that a classification system is best resolved by the definition, description and evaluation of natural wetlands plant communities.

It is recognized that most wetlands areas, with the exception of the relatively monospecific cordgrass marshes of the Eastern Shore, are not homogeneously vegetated. Most marshes are, however, dominated by a major plant. By providing the manager with the primary values of each community type and the means of identification he then has a useful and convenient tool for weighing the relative importance of each marsh parcel. In Virginia, many wetlands management problems involve only a few acres or a fraction of an acre. The identification of plant communities permits the manager to evaluate both complete marshes and subareas within a marsh.

Each marsh type may be evaluated in accordance with five general values. These are:

1. Production and detritus availability. Previous VIMS reports have discussed the details of marsh production and the role of detritus which results when the plant material is washed into the water column (Wass and Wright, 1969; Marcellus et al, 1972). The term "detritus" refers to plant material which decays in the aquatic system and forms the basis of a major marine food web. The term "production" refers to the amount of plant material which is produced by the various types of marsh plants. Vegetative production of the major species has been measured (Wass and Wright, 1969) and marshes have been rated in accordance with their average levels of productivity. If the production is readily available to the marine food web as detritus, a wetlands system is even more important than one of equal productivity where little detritus results. Availability of detritus is generally a function of marsh elevation and total flushing, with detritus more available to the aquatic environment in the lower, well-flushed marshes.

2. Waterfowl and wildlife utilization. Long before marshes were discovered to be detritus producers, they were known as habitats for various mammals and marsh birds and as food sources for migratory waterfowl. Some marsh types are more valuable from this standpoint.

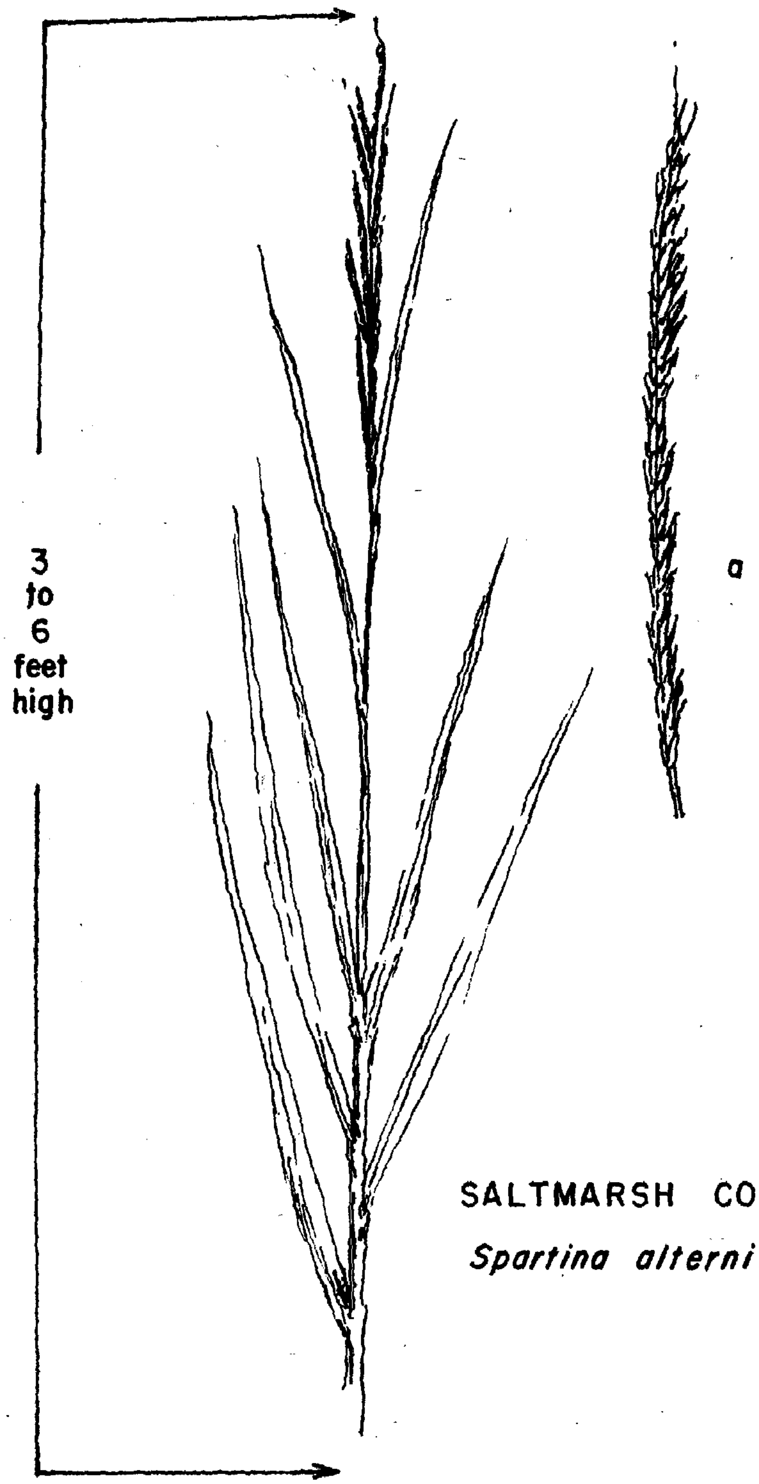
3. Erosion buffer. Erosion is a common coastal problem. Marshes

can erode but some, particularly the more saline types, erode much more slowly than do adjacent shores which are unprotected by marsh. The buffering quality is derived from the ability of the vegetation to absorb or dissipate wave energy or to establish a dense root system which stabilizes the soil. Generally, freshwater species are less effective than saltwater in this regard.

4. Water quality control. The dense growth of some marshes acts as a filter, trapping upland sediment before it reaches waterways and thus protecting shellfish beds and navigation channels from siltation. Marshes can also filter out sediments that are already in the water column. The ability of marshes to filter sediments and maintain water clarity is of particular importance to the maintenance of clam and oyster production. Excessive sedimentation can reduce the basic food supply of shellfish through reduction of the photic zone where algae grows. It can also kill shellfish by clogging their gills. Additionally, marshes can assimilate and degrade pollutants through complex chemical processes, a discussion of which is beyond the scope of this paper. Research has shown, however, that marshes act as a natural treatment system that is comparable to artificial tertiary treatment of sewage (Pomeroy, et al, 1972; Sweet, 1971; Valiela et al., 1973; Axelrad, in preparation).

5. Flood buffer. The peat substratum of some marshes acts as a giant sponge in receiving and releasing water. This characteristic is an effective buffer against coastal flooding, the effectiveness of which is a function of marsh type and size.

Research and marsh inventory work accomplished by VIMS personnel indicate that 10 species of marsh vegetation tend to dominate many marshes, the dominant plant depending on water salinity, marsh elevation, soil type and other factors. The term "dominant" is construed to mean that at least 50% of the vegetated surface of a marsh is covered by a single species. Brackish and freshwater marshes often have no clearly dominant species of vegetation. These marshes are considered to be highly valuable in environmental terms. In the following pages twelve distinct marsh types are described in detail and a brief outline of the major values of each type is presented.



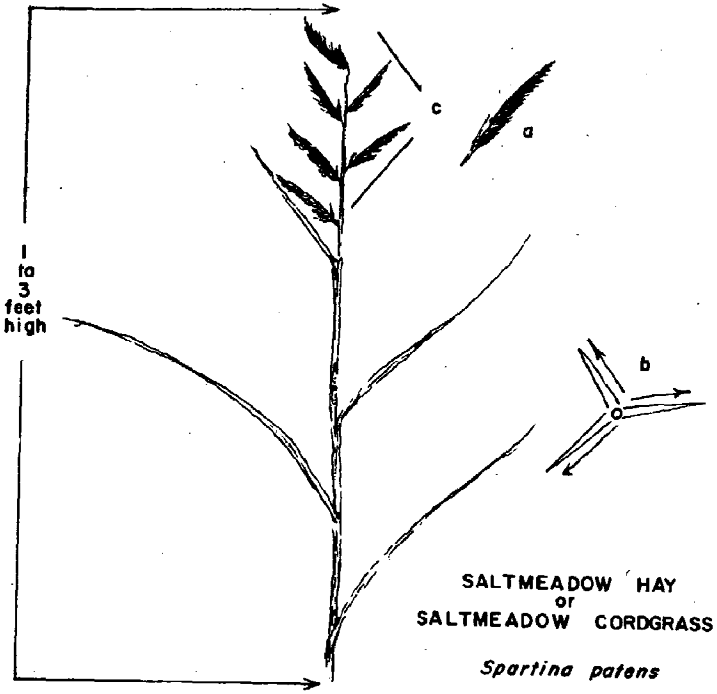
SALTMARSH CORDGRASS

Spartina alterniflora

a. Branch of fruiting head.

TYPE I. SALTMARSH CORDGRASS COMMUNITY

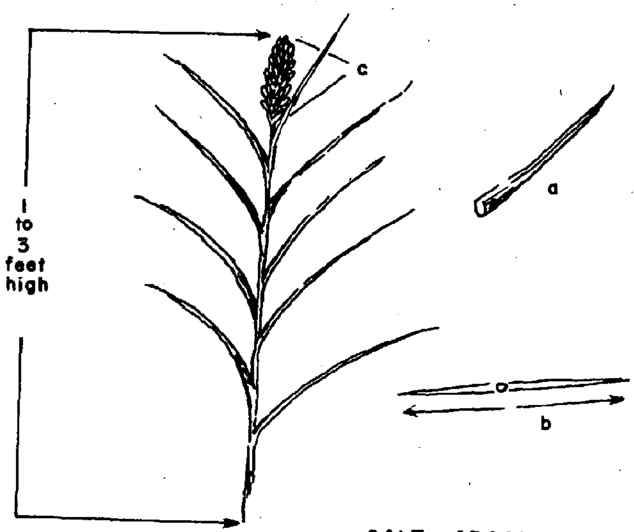
Dominant vegetation:	Saltmarsh cordgrass (*Spartina alterniflora* Loisel).
Associated vegetation:	Saltmeadow hay, saltgrass, black needlerush, saltwort, sea lavender, marsh elder, groundsel tree, sea oxeye.
Growth habit:	Stout, erect grass; long, smooth leaves, often with attached periwinkle snails; located at the waters edge. Tall form 4 to 6 feet tall along the water; short form 1 to 2 feet at or slightly higher than MHW.
Physiographic position:	Ranges from mean sea level to approximately mean high water.
Average density:	Usually 20 plants per square foot. Can range from 10 to 50 plants.
Annual production and detritus availability:	Average yield is about 4 tons per acre per annum; optimum growth up to 10 tons per acre. Daily tides flux nearly throughout this community. Available detritus to the marine environment is optimum. This type of marsh is recognized as an important spawning and nursery ground for fish.
Waterfowl and wildlife utility:	Roots and rhizomes eaten by waterfowl. Stems used in muskrat lodge construction. Nesting material for fosters tern, clapper rail and willet.
Potential erosion buffer:	Most saltmarshes and brackish water marshes are bordered by saltmarsh cordgrass along the waters edge. A marsh/water interface of this type is highly desirable as a deterrent to shoreline erosion. The plant stems and leaves tend to dissipate wave action. Underlying peat with a vast network of rhizomes and roots is very resistant to wave energy.
Water quality control and flood buffer:	Marshes of this type can also serve as traps for sediment that originate from upland runoff. This also includes large debris that may accumulate on the marsh surface. Flood waters are assimilated by the peat substrate just as water is absorbed by a sponge.
SUMMARY:	Considering the many attributes of this type of marsh community, its conservation should be of highest priority.



SALTMEADOW HAY
or
SALTMEADOW CORDGRASS

Spartina patens

a. Branch with flowers.
b. Leaves arranged in 3 or more planes.
c. Flowering or fruiting head.

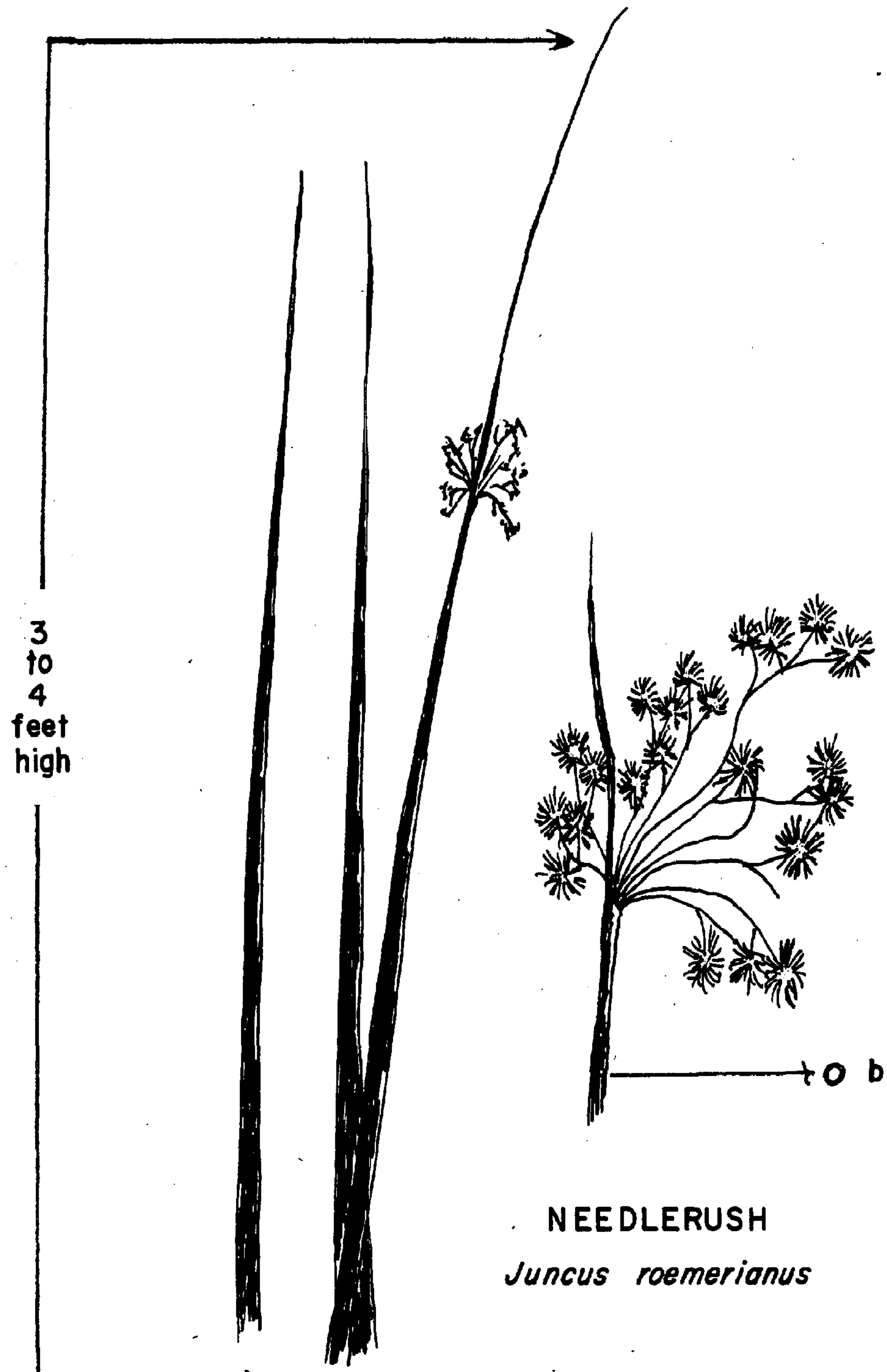


SALT GRASS
Distichlis spicata

a. Trough—shaped leaves (rolled inward).
b. Leaves arranged in one plane.
c. Flowering or fruiting head.

TYPE II. SALTMEADOW COMMUNITY

Dominant vegetation:	Saltmeadow hay (*Spartina patens* (L.) Greene) Saltgrass (*Distichlis spicata* (L.) Greene)
Associated vegetation:	Saltmarsh cordgrass, black needlerush, marsh elder, groundsel tree, saltwort, sea oxeye.
Growth habit:	Matted meadow-like stands with swirls or "cowlicks", individual plants wiry in appearance; saltgrass 1-2 feet high.
Physiographic position:	About mean high tide to the limit of spring tides; saltgrass at lower elevations, saltmeadow hay predominates at the higher end of the range.
Average density:	Mixed populations; 50-150 stems per square foot.
Annual production and detritus availability:	Ranges from 1-3 tons per acre per annum. Only small amounts of dead plant material are flushed out during storms and spring tides.
Waterfowl and wildlife utility:	Seeds eaten by birds; provides nesting area. Habitat for a snail (*Melampus*) important as food for birds.
Potential erosion buffer:	Effective erosion deterrent at higher elevations.
Water quality control and flood buffer:	In many cases, this community represents the oldest part of a marsh system. Peat may accumulate to great depths, making this type of marsh act as a giant sponge when flood waters wash over it. Denseness of vegetation and deep peat filters sediments and waste material.
SUMMARY:	This system is an excellent buffer, filtering out sediments, wastes and absorbing runoff water originating in the uplands. It may be a better absorbent than Type I since it is not flooded daily by tides and its substrate is seldom saturated with water. Production and detritus are less important to the marine environment than in Type I communities. Its contributions tend to favor the upland environment. Its values rank somewhat below Type I but, nevertheless, a Type II marsh should not be unnecessarily disturbed.



NEEDLERUSH

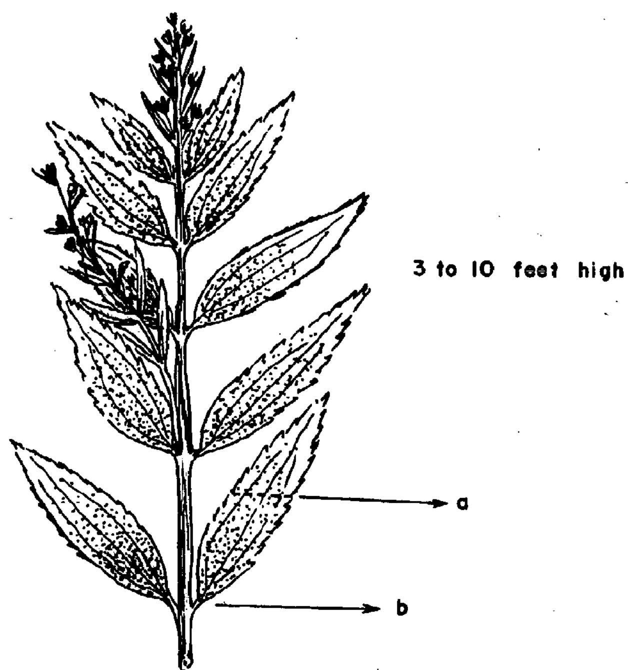
Juncus roemerianus

a. Fruiting head.

b. Stem round in cross section.

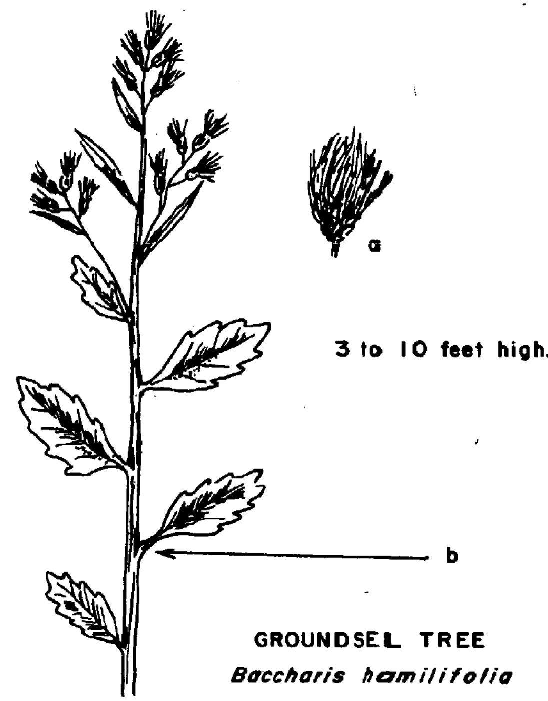
TYPE III. BLACK NEEDLERUSH COMMUNITY

Dominant vegetation:	Black needlerush (*Juncus roemerianus* Scheele.)
Associated vegetation:	Usually pure stands with saltmarsh cordgrass, saltgrass and saltmeadow hay near the margin.
Growth habit:	Dense monospecific stands; plant leafless, cylindrical hard stems tapering to a sharp pointed tip; brown to dark green in color, 3 to 5 feet high.
Physiographic position:	About mean high water to somewhat below spring tide limit. Seems to prefer sandy substratum.
Average density:	30 to 50 stems per square foot.
Annual production and detritus availability:	3 to 5 tons per acre per annum, decomposes more slowly than most of the marsh grasses. Not fluxed daily by tides.
Waterfowl and wildlife utility:	There is no evidence that waterfowl or wildlife utilize this type of plant directly as a food. Because of the dense, stiff stands, it has little wildlife value except for limited cover.
Potential erosion buffer:	Recent investigations have shown that the dense system of rhizomes and roots of black needlerush are highly resistant to erosion. On sandy shores and low sand berms which support this community type, this characteristic is of high value.
Water quality control and flood buffer:	An effective trap for suspended sediments, but less effective than the densely matted saltmeadow community. Provides effective absorbent areas to buffer coastal flooding.
SUMMARY:	As a single monospecific community this type would support less diversity of wildlife than Type I and II. It functions quite well as a sediment trap and erosion deterrent. However, in these categories it ranks lower than the preceding types. The rhizomes of black needlerush are harder and tougher than the grasses that dominate Types I and II communities;therefore, needlerush is useful as an erosion deterrent. Overall, the values of this marsh type rank below Types I and II.



MARSH ELDER
Iva frutescens

a. Leaves thick and fleshy.
b. Leaves opposite each other on the stem.

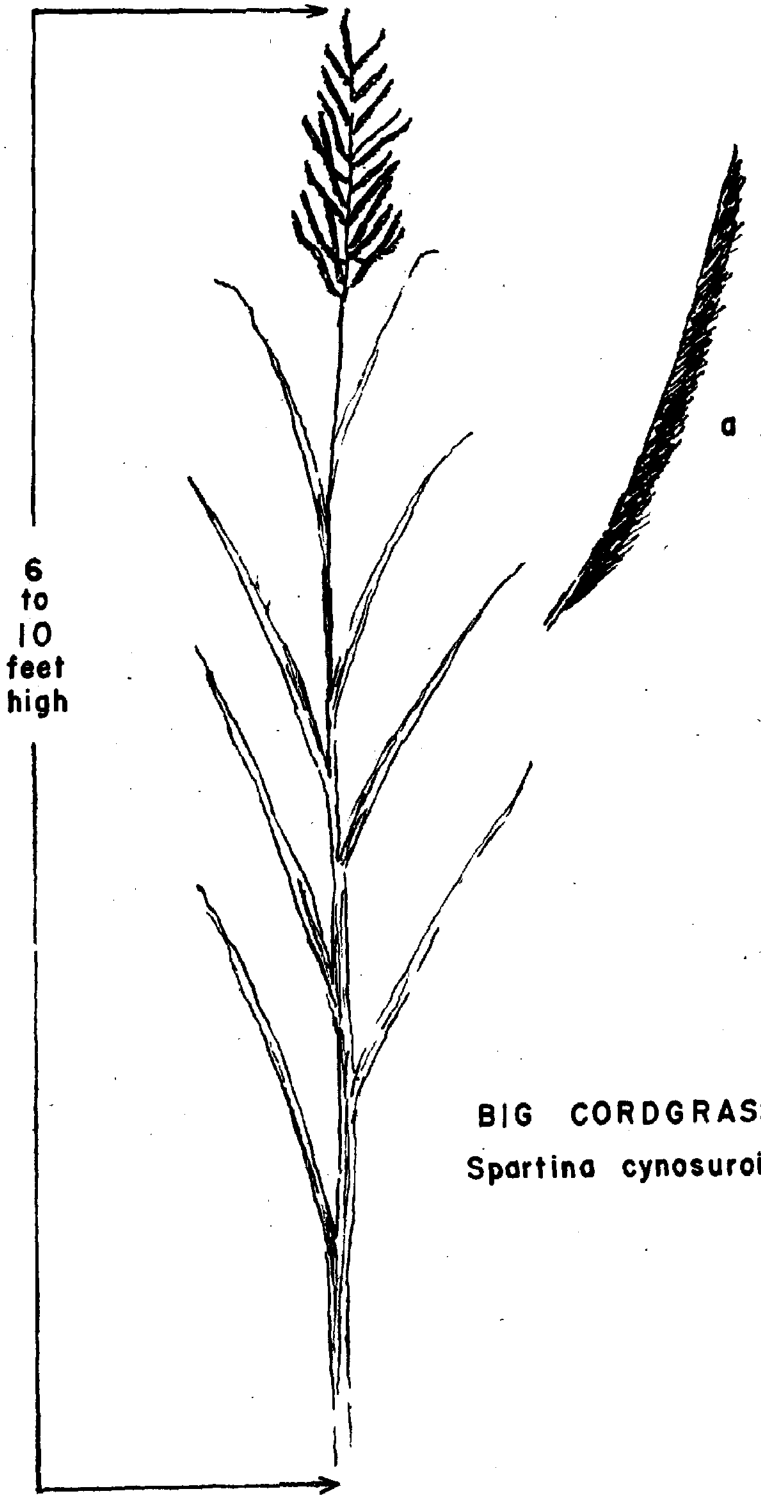


GROUNDSEL TREE
Baccharis hamilifolia

a. Fruiting head.
b. Leaves alternate.

TYPE IV. SALTBUSH (GALLBUSH) COMMUNITY

Dominant vegetation:	Groundsel tree, highwater bush (*Baccharis halimifolia* L.), marsh elder, saltwater bush (*Iva frutescens* L.)
Associated vegetation:	Saltmeadow hay, saltgrass, wax myrtle, sea oxeye
Growth habit:	Shrubs 3 to 10 feet high along the margin of the marsh and upland plant communities.
Physiographic position:	Lower limit is approximately the upper limit of marsh (marsh-upland ecotone).
Average density:	May provide dense canopy over marsh. Individual shrub trunks usually spaced 3 to 10 feet apart.
Annual Production and detritus availability:	Probably less than 2 tons per acre per annum. Detritus of little value.
Waterfowl and wildlife utility:	Provides diversity for wildlife in general and especially as a nesting area for small birds. No significant food value.
Potential erosion buffer:	Although not structurally suited as an assimilator of sediment and flood waters, it serves somewhat as a buffer to erosion on sand berms that often front small pocket marshes. Also functional as a trap for larger flotsam.
Water quality control and flood buffer:	Of minor consequence, but does trap larger material. (See above).
SUMMARY:	Useful as an indicator of upper limits of marshes as defined in the Wetlands Act. Values of this type rank below that of the preceding types. However, this community does add diversity to the marsh ecosystem.

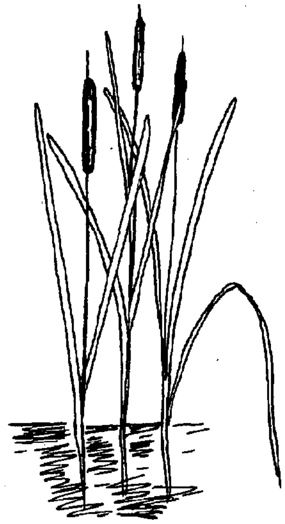


BIG CORDGRASS
Spartina cynosuroides

a. Branch of fruiting head.

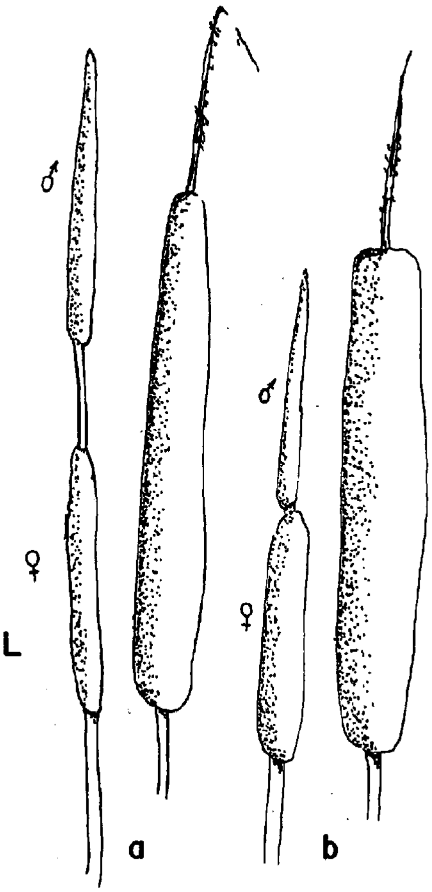
TYPE V. BIG CORDGRASS COMMUNITY

Dominant vegetation:	Big cordgrass (Spartina cynosuroides (L.) Roth.)
Associated vegetation:	Usually pure stands
Growth habit:	Very tall (6-12 feet), heavily stemmed, leafy grass with distinct branched fruiting head in the fall.
Physiographic position:	At or slightly above mean high water and extending to the upland margin. Most common in brackish or low salinity marshes.
Average density:	10 to 15 stems per square foot.
Annual production and detritus availability:	3 to 6 tons per acre per annum. Detritus accessible only on spring or wind tides, however is rivaled only by saltmarsh cordgrass, which gives big cordgrass a higher value in the context of production than other grasses found above mean high tide. Decomposes more slowly than saltmarsh cordgrass.
Waterfowl and wildlife utility:	Utilized as a habitat by small animals, often used for muskrat lodges. Geese often eat its rhizomes.
Potential erosion buffer:	The large, coarse rhizomes and intertwining roots stabilize peat along marsh edges.
Water quality control and flood buffer:	Usually this community type occupies the older parts of a marsh system where peat may be deeper increasing its capacity as a flood water assimilator. It is also useful in trapping flotsam.
SUMMARY:	Although the elevation occupied by this community type is similar to that of the saltmeadow community, big cordgrass has a much higher yield of organic matter which likely contributes to the marine food web. It is also relatively high in value as a wildlife food as well as a buffer to erosion.



NARROW-LEAVED CATTAIL
Typha angustifolia

COMMON CATTAIL
Typha latifolia

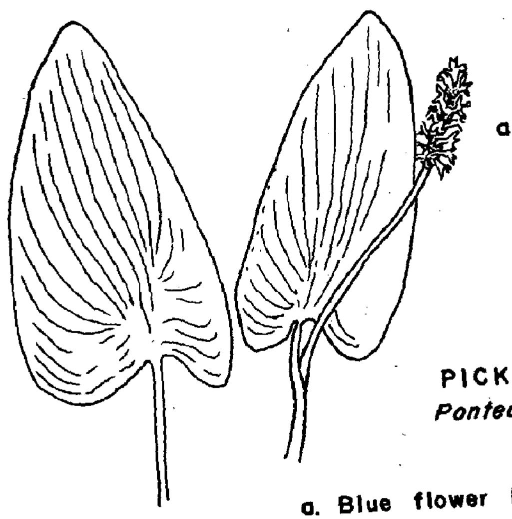


a. Narrow-leaved cattail (Flower and fruiting head)
b. Common cattail (Flower and fruiting head)

Illustrations after Fassett, A Manual of Aquatic Plants.

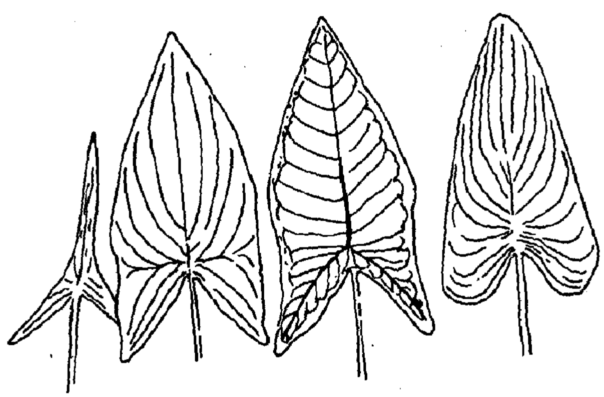
TYPE VI. CATTAIL COMMUNITY

Dominant vegetation:	Narrowleaf cattail (*Typha angustifolia* L.)
Associated vegetation:	Broadleaf cattail (*Typha latifolia* L.), sedges, bulrushes, arrow arum, pickerel weed, smartweed, other fresh or brackish water plants.
Growth habit:	Characteristic "wiener on a stick" fruiting heads, long strap-like leaves, somewhat blunted tips. 4 to 6 feet tall.
Physiographic position:	Very wet sites, sometimes in standing water, often at the margin of marsh and uplands. Does well in seepage areas resulting from upland runoff.
Average density:	2 to 6 stalks per square foot.
Annual production and detritus availability:	2 to 4 tons per acre. Detritus usually not readily accessible to the marine environment.
Waterfowl and wildlife utility:	Provides habitat for certain birds; roots consumed by muskrats.
Potential erosion buffer:	Because of its preferred habitat and its characteristic shallow root system, Type VI is only a minor buffer to erosion.
Water quality control and flood buffer:	Its usual habitat along the upland margins in soft muddy areas ranks this marsh type high as a sediment trap despite its shallow rooted condition. Very few species will grow in these areas either because of the stagnant condition of the substratum or because they are inhibited by toxin release of the cattail roots or a combination of the two factors.
SUMMARY:	Because of its value as a wildlife food and habitat, its function as a sediment trap, its relatively high production and the usual soft substratum, this type of marsh community should not be indiscriminately used as a development site. As far as overall value is concerned it compares with a saltmeadow marsh (Type II).

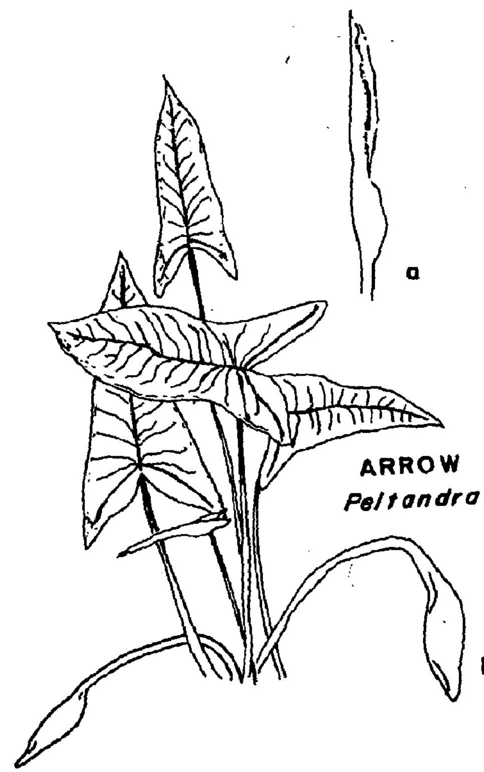


PICKEREL WEED
Pontederia cordata

a. Blue flower head



Arrowhead   Arrow Arum   Pickerel Weed



ARROW ARUM
Peltandra virginica

a. Flower head
b. Fruiting head

TYPE VII. ARROW ARUM - PICKEREL WEED COMMUNITY

Dominant vegetation:	Arrow arum (Peltandra virginica (L.) Kunth.) Pickerel weed (Pontederia cordata L.)
Associated vegetation:	Sedges, smartweeds, bulrushes, ferns, cattails, pond lily.
Growth habit:	Many broad leaved clumps growing from a thick, cylindrical rhizome; arrow or heart shaped leaves. Clumps 2 to 6 feet tall, average height 3 feet.
Physiographic position:	On tidal mud flats from mean sea level to about mean high tide in low salinity or freshwater marshes.
Average density:	1 or 2 clumps per 10 square feet.
Annual prodution and detritus availability:	2 to 4 tons per acre. Detritus readily available to the marine food web because of daily tide fluxes. In the fall of the year these species decompose quite rapidly and completely except for the root stock.
Waterfowl and wildlife utility:	Seeds and shoots of both species are eaten by ducks. Arrow arum seeds float after the pod decays and are readily available for wood ducks. Often associated with confirmed spawning and nursery areas for herring and shad.
Potential erosion buffer:	Although this community type lacks the vast network of rhizomes, roots and peat substratum typical of a saltmarsh cordgrass community, this marsh/water interface vegetation is often the only vegetative buffer to shoreline erosion in freshwater areas. The substratum in a marsh such as this is typically soft, unstable mud. After the vegetation has decayed in the winter time, the mud flats are highly susceptible to erosion due to winter rains.
Water quality control and flood buffer:	Slows the flow of flood waters, causing some suspended sediment to settle out.
SUMMARY:	Under natural conditions the marsh of this type is relatively stable but it is highly sensitive to development and activities such as excessive boat traffic. Because of its many attributes this marsh ranks similar to that of Type I.

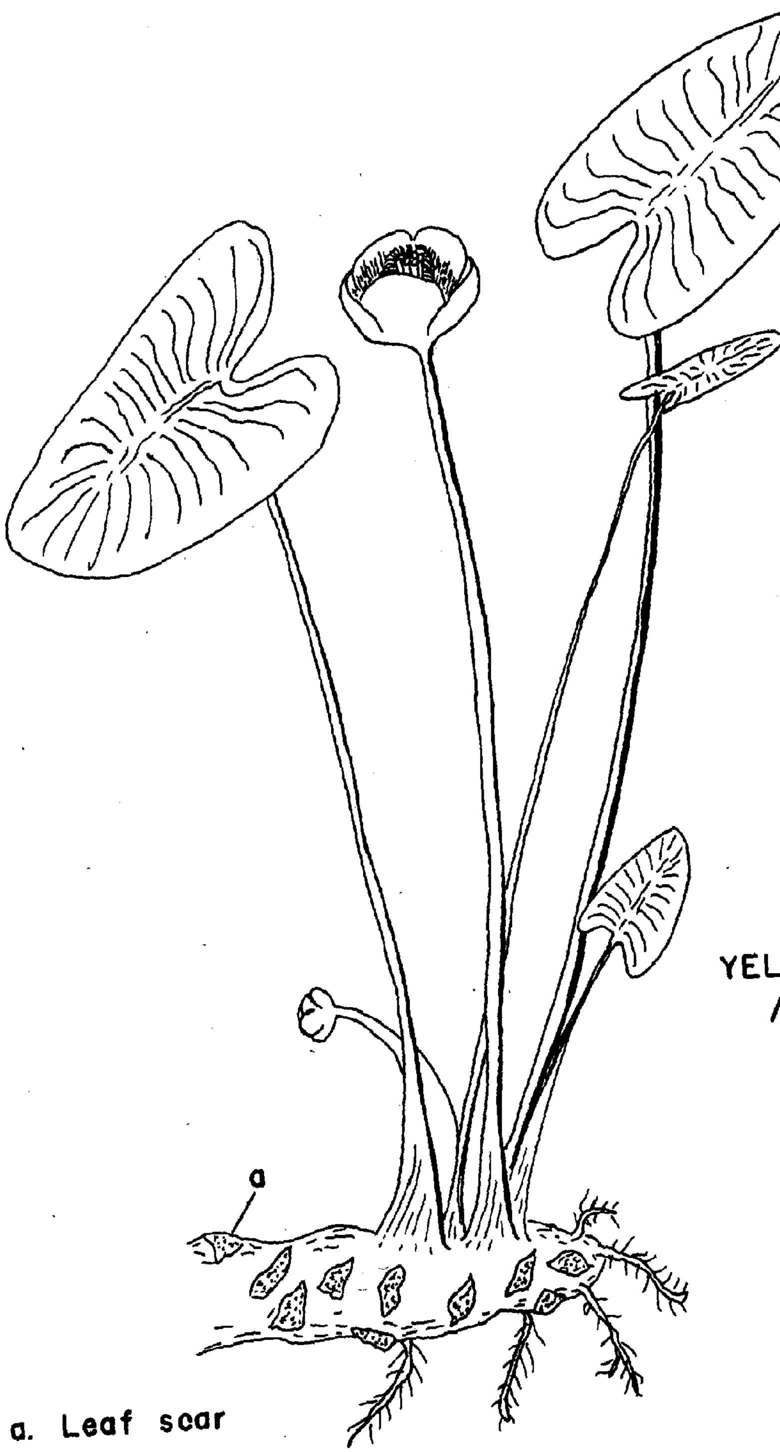
REED GRASS
Phragmites australis

a. Stand in winter condition, without leaves

TYPE VIII. REED GRASS COMMUNITY

Dominant vegetation:	Reed grass(*Phragmites australis*) *
Associated species:	Switch grass, saltbushes, a few others.
Growth habit:	Tall stiff grass with short, wide leaves tapering abruptly to a point; soft plume-like seed head. 6 to 10 feet high.
Physiographic position:	Usually above mean high tide, drier areas on disturbed sites.
Average density:	3 to 6 stems per square foot.
Annual production and detritus availability:	4 to 6 tons per acre, detritus seldom available except in storm conditions.
Waterfowl and wildlife utility:	Little direct value to wildlife except as cover. May have a detrimental effect in that it can invade areas of a marsh and compete with desirable species. It appears to be replacing big cordgrass and other plants in freshwater marshes of the Pamunkey River.
Potential erosion buffer:	Good erosion deterrent on disturbed sites, especially on spoil.
Water quality control and flood buffer:	Valuable as a buffer to erosion. Potential as sediment trap and flood deterrent appears to be minimal.
SUMMARY:	This plant is a relatively recent invader in Virginia but is spreading rapidly, often displacing more important marsh plants. It has little or no value to wildlife in general. Its only important value would be its function as a stabilizer on dredge spoil. This community type ranks below a Type III marsh, the black needlerush community.

*Formally *Phragmites communis* Trinius

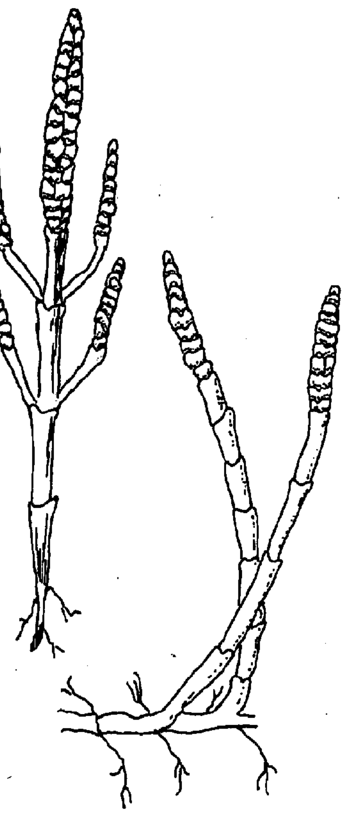


YELLOW POND LILY
Nuphar advena

a. Leaf scar

TYPE IX. YELLOW POND LILY COMMUNITY

Dominant vegetation:	Yellow pond lily, spatter-dock (Nuphar luteum (L. Sibthrop and Smith)
Associated vegetation:	Pickerel weed, arrow arum.
Growth habit:	Saucer shaped leaves with a narrow notch, floating on water; large, leathery yellow flower. 2 to 4 feet high from submerged root stalk.
Physiographic position:	Submerged except for floating leaves at high tide. Found in freshwater areas.
Average density:	One plant (cluster of leaves) for every 3 to 5 square feet.
Annual production and detritus availability:	$\frac{1}{2}$ to 1 ton per acre; detritus readily available but not a significant contributor to the food chain.
Waterfowl utility:	Excellent cover and attachment site for aquatic animals and algae. Feeding territory for aquatic birds and fish.
Potential erosion buffer:	While lacking the stiffness of grasses and sedges, these plants do reduce wave action from wind and boats. This has been noted in freshwater streams and boat channels.
Water quality control and flood buffer:	Although not a direct assimilator of sediments and flood waters, the flow of flood water is slowed somewhat and sediments can settle out. This function is minimal because the community is submerged completely in flood conditions.
SUMMARY:	Destruction of the community would result in a decrease in number and diversity of aquatic animal life in the immediate area. The greatest value the community has is its habitat for aquatic biota. This type should be ranked with or slightly higher than a Type III (black needlerush) marsh.



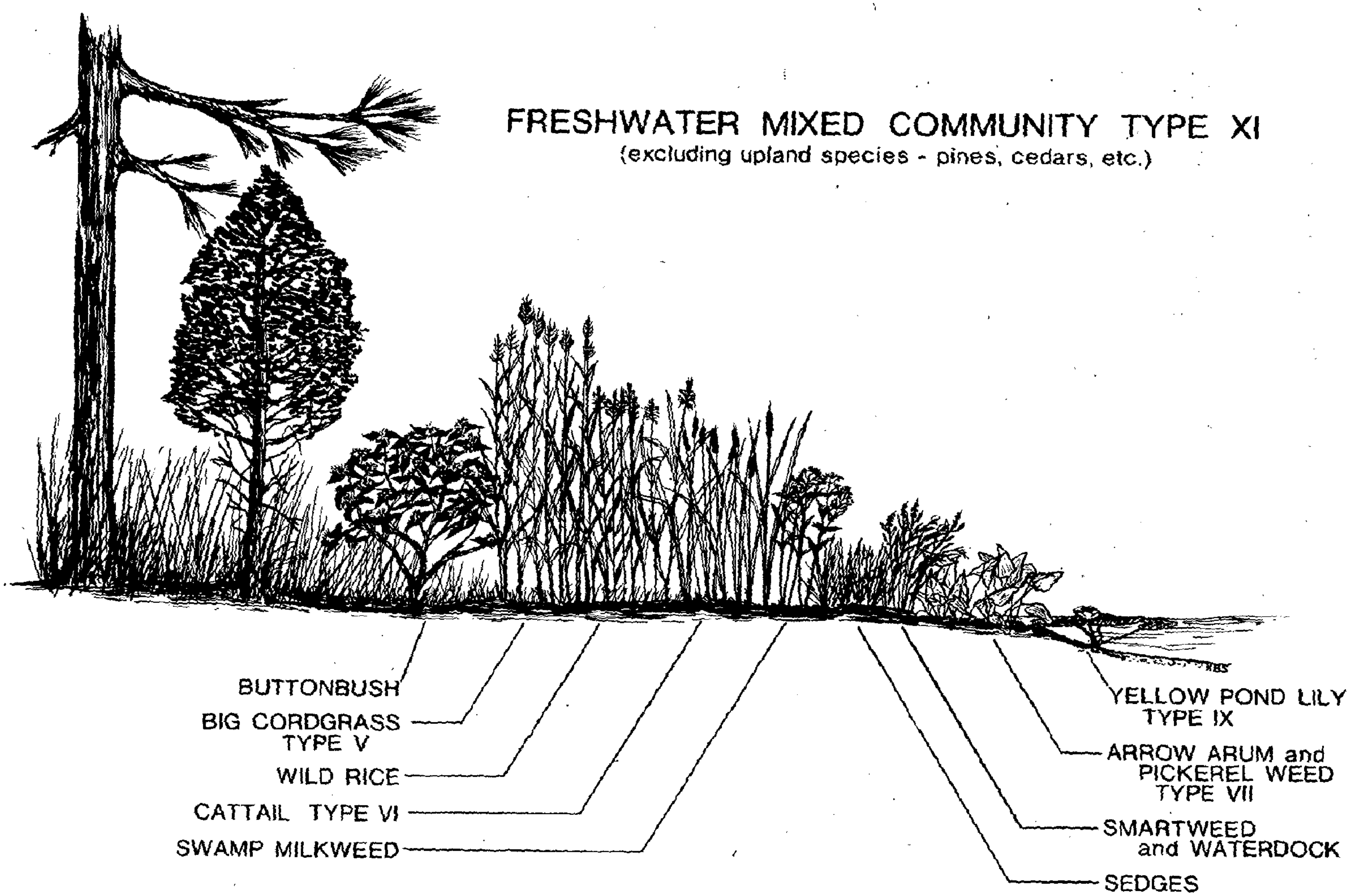
SALTWORT
Salicornia sp.

TYPE X. SALTWORT COMMUNITY

Dominant vegetation:	Saltwort, glasswort (Salicornia spp.)
Associated vegetation:	Saltmarsh cordgrass, saltgrass, sea lavender.
Growth habit:	Leafless green fleshy--stemmed plant, red in color in fall; 8 inches to $1\frac{1}{2}$ feet tall.
Physiographic position:	Above mean high tide in pannes or sparsely vegetated areas.
Average density:	10 to 15 stems per square foot.
Annual production and detritus availability:	Less than $\frac{1}{2}$ ton per acre. Exerts very little influence on the marine environment.
Wildlife and waterfowl utility:	Some evidence that stems are eaten by ducks. May be a feeding area for other marsh birds.
Potential erosion buffer:	Has very little value as an erosion deterrent.
Water quality control and flood buffer:	Because of the character of the stem, a shallow root system and the usual small sizes of the populations, these community types have little or no value in this category.
SUMMARY:	This community is not high in value. It usually occupies small areas within larger more productive marshes and can be used as an indicator of higher marsh elevations.

FRESHWATER MIXED COMMUNITY TYPE XI

(excluding upland species - pines, cedars, etc.)

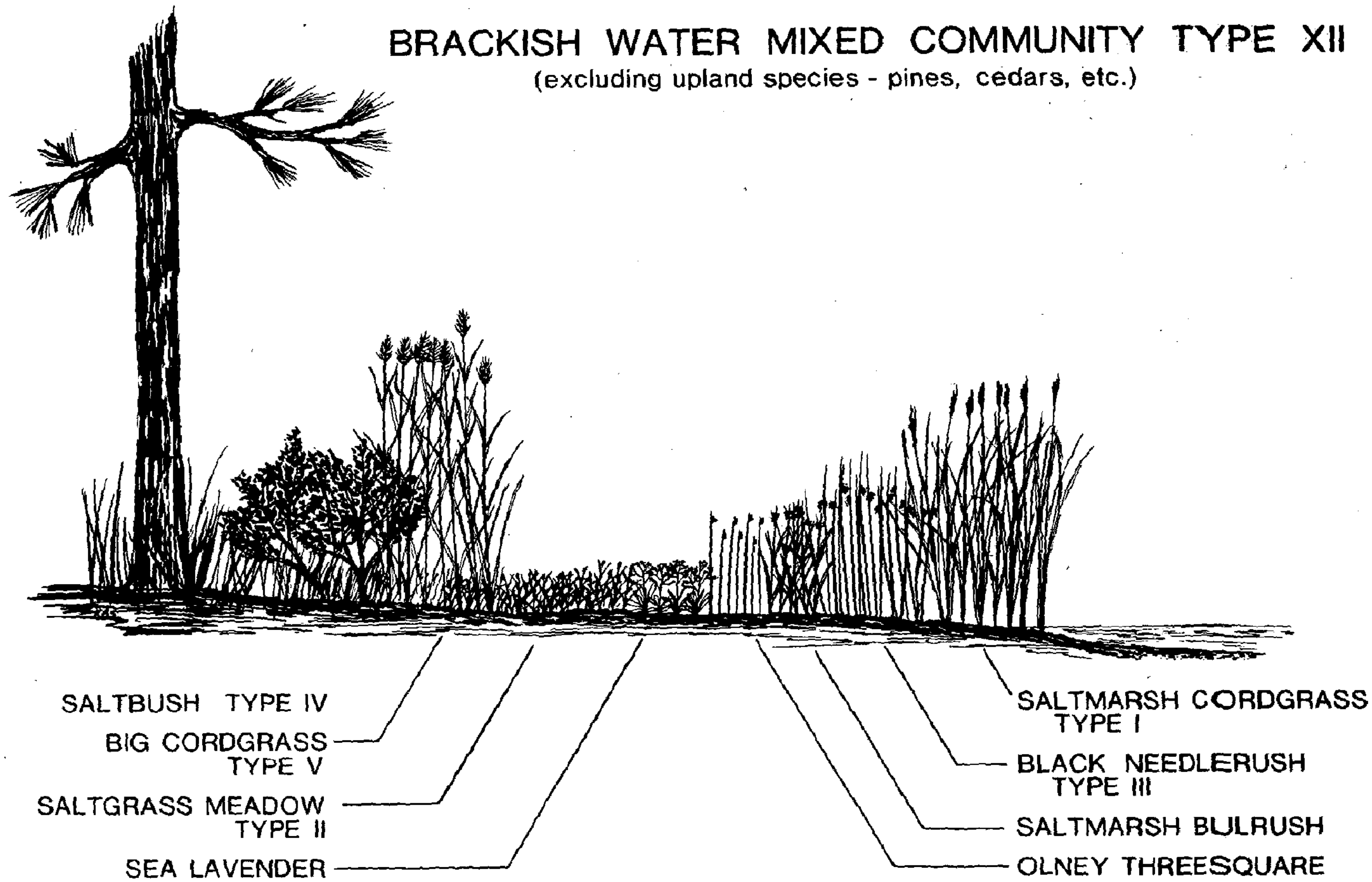


TYPE XI. FRESHWATER MIXED COMMUNITY

Dominant vegetation:	No single species covers more than 50% of the site.
Associated vegetation:	Bulrushes, sedges, waterdock, smartweeds, ferns, pickerel weed, arrow arum, wildrice, beggar's ticks, rice cutgrass.
Growth habit:	Heterogeneous mixture of plants.
Physiographic position:	From submerged to the upper limits of the wetlands.
Average density:	Highly variable.
Annual production and detritus availability:	3 to 5 tons per acre. Detritus of species such as arrow arum, pickerel weed and yellow pond lily would be available in the intertidal zone.
Waterfowl and wildlife utility:	A highly valuable marsh for a broad diversity in wildlife species. Plant species such as smartweeds, waterdock, wildrice and others are prime waterfowl and sora rail foods. Waters adjacent to these type marshes are also known as spawning and nursery grounds for striped bass, shad and river herring.
Potential erosion buffer:	Shoreline erosion protection provided by this type of marsh is equivalent to Type VII, arrow arum - pickerel weed community.
Water quality control and flood buffer:	This ranks somewhat higher as a sediment trap and flood deterrent than an arrow arum - pickerel weed community. The presence of the stiffer, more resilient grasses, sedges and rushes and peaty-type substratum increases the ability of this type of community over a Type VII marsh as an assimilator of sediments and flood waters.
SUMMARY:	These are very valuable marshes and the aim should be to keep them in a natural state. This type of marsh would be ranked equivalent to a saltmarsh cordgrass marsh (Type I) and an arrow arum - pickerel weed (Type VII) marsh.

BRACKISH WATER MIXED COMMUNITY TYPE XII

(excluding upland species - pines, cedars, etc.)



TYPE XII. BRACKISH WATER MIXED COMMUNITY

Dominant vegetation:	No single species covers more than 50% of the site.
Associated vegetation:	Saltmarsh cordgrass, saltmeadow hay, saltgrass, black needlerush, saltbushes, three squares, big cordgrass, cattails.
Growth habit:	Heterogeneous mixture of plants in wet areas.
Physiographic position:	Extending from about mean sea level to the upland margin.
Average density:	Highly variable.
Annual productivity and detritus availability:	3 to 4 tons per acre, detritus readily available in the intertidal zone.
Waterfowl and wildlife utility:	Wide diversity of vegetation provides a variety of wildlife food. Waterfowl foods are plentiful, such as the generous seed heads of saltmarsh bulrush.
Potential erosion buffer:	Shoreline erosion protection is the same as that of a Type I marsh (saltmarsh cordgrass). Most brackish water marshes are bordered by saltmarsh cordgrass.
Water quality control and flood buffer:	Ranks high in this category, having similar attributes as a Type II marsh (saltmeadow).
SUMMARY:	This marsh is a microcosm of all the communities found in saline waters. Brackish water marshes are known spawning and nursery grounds. This community type contains valuable food and habitat for a wide diversity of wildlife species. Ranks with a Type I (saltmarsh cordgrass) marsh.

SECTION III

EVALUATION OF WETLANDS TYPES

The Wetlands Act requires the Virginia Institute of Marine Science to evaluate wetlands by type (Code of Virginia 62.1-13.4). There are several methods in which values can be placed on wetlands. One of these methods was attempted in a recent study (Gosselink, et al.,1973) in which dollar values per acre of marsh were established based on the natural contributions and functions of an undisturbed marsh. The same report cited another method in which marsh values are determined by the commercial market price; presumably these marshes would be sold for commercial uses which would ultimately destroy the natural properties of the marshes. There are also aesthetic values attributable to marshes but these cannot be effectively evaluated by managers or scientists in that aesthetic values are an individual judgment.

Establishment of a per acre value of wetlands types in a monetary sense has not been attempted in this report. One Wetlands Board chairman doubts that a monetary value would be helpful and suggests that it might lead to poor decisions based on face value trade-offs which ignore the fact that wetlands are rarely replaceable (Odom, 1973). An examination of the quality of each type marsh contained in Section II, however, leads to the conclusion that there are relative environmental properties which can be assessed on a no unit basis. Such an assessment can lead to a ranking system which may be of value to managers.

For management purposes, then, the twelve types of wetlands identified in Section II are grouped into five classifications based on the estimated total environmental value of an acre of each type.

<u>Group One</u>:

Saltmarsh cordgrass (Type I)
Arrow arum - pickerel weed (Type VII)
Freshwater mixed (Type XI)
Brackish water mixed (Type XII)

Group One marshes have the highest values in productivity and wildfowl and wildlife utility and are closely associated with fish spawning and nursery areas. They also have high values as erosion inhibitors, important to the shellfish industry and valued as natural shoreline stabilizers. Group One marshes should be preserved.

<u>Group Two</u>:

Big cordgrass (Type V)
Saltmeadow (Type II)
Cattail (Type VI)

Group Two marshes are of only slightly lesser value than Group One marshes. The major difference is that detritus produced in these marshes is less readily available to the marine environment due to higher elevations and consequently less tidal action to flush the detritus into adjacent waterways. Group Two marshes have very high values in protecting water quality and acting as buffers against coastal flooding. These marshes should also be preserved, but if development in wetlands is considered to be justified it would be better to alter Group Two marshes than Group One marshes.

Group Three: Yellow pond lily (Type IX)
Black needlerush (Type III)

The two marshes in the Group Three category are quite dissimilar in properties. The yellow pond lily marsh is not a significant contributor to the food web but it does have high values to wildlife and waterfowl. Black needlerush has a high productivity factor but a low detritus availability value. Black needlerush has little wildlife value but it ranks high as an erosion and flood buffer. Group Three marshes are important though their total values are less than Group One and Two marshes. If development in wetlands is considered necessary, it would be better to alter Group Three marshes than Groups One or Two.

Group Four: Saltbush (Type IV)

The saltbush community is valued primarily for the diversity and bird nesting area it adds to the marsh ecosystem. To a lesser extent it also acts as an erosion buffer. Group Four marshes should not be unnecessarily disturbed but it would be better to concentrate necessary development in these marshes rather than disturb any of the marshes in the preceding groups.

Group Five: Saltwort (Type X)
Reedgrass (Type VIII)

Based on present information Group Five marshes have few values of any significance. While Group Five marshes should not be unreasonably disturbed, it is preferable to develop in these marshes than in any of the other types.

MARSH VALUES AS RELATED TO MARSH SIZE

The ranking system thus established is a partial tool for use in making decisions to alter wetlands for it measures only one marsh type against another. Other factors, involving a wholistic view of the creek or river systems involved, may be considered in the decision making process.

For example, acreage is an obviously important factor to consider when evaluating a specific marsh. A 5 acre marsh is inherently more valuable than a smaller marsh of the same type. Many creeks and rivers in Virginia however, have wetlands bordering them which are a series of small separate marshes. The value of these, when considered in their totality, may be as great as a single marsh of the same type and acreage.

Much is yet to be learned and further research is required to determine at what point significant values attributable to a marsh type or marsh system cease to exist from a practical management viewpoint. Enough is known from experience gained in the Virginia marsh inventory to date, however, to establish conservative guidelines for use on an interim basis. These are:

a. Any marsh which is 2 feet or more in average width is considered to have significant values as an erosion deterrent and in filtering sediments coming from the uplands. It may also have other values depending upon the total acreage of the marsh parcel.

b. Any marsh which is greater than 1/10 of an acre in size may have, depending on type and viability, significant values in terms of productivity, detritus availability and wildlife habitat. Depending on its location, it may also have value as an erosion buffer.

It is emphasized that the foregoing evaluation of marshes is designed for use by persons involved in managing wetlands in accordance with the Wetlands Act. There is a need to more accurately evaluate specific marshes, especially from a wholistic viewpoint. Along with a continuing inventory of wetlands, so essential to sound management, VIMS is continuing research to develop a formula by which all of the wetlands in the state can be evaluated more effectively.

SECTION IV

CONSEQUENCES OF ALTERING WETLANDS

Sections II and III define and evaluate wetlands by types. The Wetlands Act also requires that the consequences of use of the wetlands types be set forth (Code of Virginia, 62.1-13.4). There are certain uses of and activities in wetlands which are automatically permitted (Code of Virginia, 62.1-13.5(3)). Most of the permitted activities are of low intensity in nature, are compatible with the normal functions of a marsh, and therefore have no significant adverse consequences. It may have been the legislative intent that all of the permitted uses would be essentially non-degrading to wetlands. In the light of experience, however, some of the permitted activities, such as governmental activities in marshes owned or leased by the Commonwealth, should be reexamined with a view toward bringing them under more positive control. In the meantime, this report addresses those activities which result in altering marshes and which require specific permits in accordance with the Wetlands Act. These are activities which inherently degrade or destroy wetlands.

Neither we nor anyone else can, at this time, establish the finite amount of wetlands which can be destroyed or degraded without seriously affecting fisheries, wildfowl and animal populations, shoreline stability, water quality or protection from coastal flooding. It is therefore necessary that activities in Virginia's wetlands be limited to those which are considered highly essential. Loss of wetlands in Virginia through man's activities has been reported for a fifteen year period commencing in 1955 (Settle, 1969). According to the report, the average rate of loss in the period 1965-1969 was about 450 acres annually and the rate of loss was projected to reach about 600 acres annually for the period 1970-1974. Certainly natural recruitment has not kept pace with losses to date. The Norfolk District of the Corps of Engineers is attempting to establish 25 acres of marsh from dredge spoil, but it is too early to say whether the effort will be successful. Marshes represent only one-half of one percent of the total area of the State (Wass, 1969). With such a limited resource and with a destruction rate far in excess of current recruitment, VIMS concludes that all uses or activities which destroy or degrade any type of wetlands have consequences which are environmentally undesirable.

In individual projects, the degree of undesirability can be related to the size of the project and the amount of marsh destroyed. Because of their greater potentiality for larger scale adverse effects, big projects obviously attract attention. However, there should also be a concern for the cumulative effect of small projects. It was estimated that 27% of the wetlands lost in the period 1955-1969 were as the result of residential development and only 17% of the loss was charged to industrial projects (Settle, 1969). Channelization accounted for 47% of the loss but the purposes of the channelization--whether for residential or industrial purposes--were not specified. According to VIMS data for calendar year 1973, about 60% of all permit applications (both subaqueous and wetlands) were for projects involving single family residences. VIMS does not have complete data concerning final approval or modification of permit applications. However, if all applications pertaining to single family residences were approved as received, cumulative alterations to the shoreline (not counting piers and groins) would have amounted to:

Filling of 27.6 acres of wetlands.
Dredging of 95,232 cubic yards from both wetlands
and subaqueous beds.
Bulkheading of 5 miles of Virginia's shoreline.

It is known that not all applications were approved and that many were modified in order to reduce adverse effects on the environment. Nevertheless the figures are significant and take on added importance in the light of a projected population increase of 1.5 million in Tidewater Virginia by the year 2,000 (Division of State Planning and Community Affairs, 1972).

It is important that wetlands managers not lose sight of the fact that a proposal involving a small marsh or marsh segment is just one of hundreds of like nature which, on a statewide scale, account for a really extensive encroachment on Virginia's finite wetlands inventory.

SECTION V

RECOMMENDED GUIDELINES WHEN ALTERING WETLANDS

The previous sections meet the legislative requirement that VIMS provide advice and assistance to the Virginia Marine Resources Commission in promulgating guidelines which scientifically evaluate wetlands by type and which set forth the consequences of use of the wetlands types (Code of Virginia, 62.1-13.4). However, VIMS is mindful of other legislative provisions designed to afford a measure of protection to wetlands. The legislature established a policy "to preserve the wetlands and to prevent their despoilation and destruction and to accomodate necessary economic development in a manner consistent with wetlands preservation" (Code of Virginia, 62.1-13.1; emphasis added.) This portion of this report addresses the foregoing policy. It is provided to the Marine Resources Commission as interim environmental guidelines to apply in evaluating individual permit applications.

Many of the guidelines have been previously published (Marcellus et al, 1972) and have been utilized by the VMRC and local wetlands boards. Partial monitoring of permit actions of the permitting agencies clearly shows that many proposed uses of the shoreline can be accomodated with little or no loss of wetlands if the suggested guidelines are applied. Guidelines which are included herein but were not previously published have been developed in the light of experience gained by investigating and reporting on all wetlands actions since the effective date of the Wetlands Act, July 1972.

There are times, of course, when guidelines may not apply in specific cases. The conscientious application of the guidelines will, however, materially reduce adverse environmental impacts of man's activities on the shoreline and it is recommended that the Commission, as the management agency responsible, adopt them and promulgate them for guidance of local wetlands boards.

GENERAL GUIDELINES

A. Provided significant marine fisheries, wetlands and wildlife resources are not unreasonably detrimentally affected, alteration of the shoreline or construction of shoreline facilities may be justified in order to:

1. Gain access to navigable water by:

    a. Commercial and industrial activities for which it has been clearly demonstrated that waterfront facilities are required.

    b. Marinas, camps, boat yards, yacht clubs and other activities which provide broad recreational access to the water.

    c. Owners of land adjacent to waters of navigable depth or waters which can be made navigable with only negligible adverse impact on the environment.

2. Protect property from significant damage or loss from erosion or other natural causes.

RATIONALE: These general uses are in accordance with recognized riparian rights (see United States vs. Smoot Sand and Gravel Corp., 248F. 2nd, 822 (4th Cir. 1957) or are activities which provide benefits to the public in general. It must also be remembered, however, that Virginia's shoreline is one of her greatest finite natural resources.

B. Alteration of the shoreline is ordinarily not justified:

1. For purposes or activities which could just as well be conducted on existing fastlands and which have no inherent requirement for access to water resources.

2. For purposes of creating waterfront property from lots and subdivisions which are not naturally contiguous to waters of navigable depth or waters which can only be made navigable by substantial alteration or destruction of marine resources.

3. When damage to properties owned by others is a likely result of a proposed activity.

4. When the alteration will result in discharge of effluents which impair wetlands, water quality or other marine resources.

5. When there are viable alternatives which can achieve a given purpose without adversely affecting marshes, oyster grounds or other natural resources, or where any adverse effects are negligible.

RATIONALE: These guidelines reserve the shoreline for those uses or activities which require water access. They also discourage activities such as dredging into the fastlands for housing developments which often have a significant and long term adverse impact on the marine environment through such effects as changed upland hydrology, sedimentation, changes in water current patterns near the shoreline, and the introduction of pollutant discharges which frequently lead to closure of shellfish grounds. The dredging of channels into fastlands may also lead to deterioration of ground water by salt water intruding into aquifers.

C. Utilization of open-pile type structures for gaining access to water is generally preferred over the construction of solid structures or dredging or filling.

RATIONALE: The construction of solid structures, or the conduct of dredging and filling operations, often causes irretrievable loss of marsh through their direct displacement or by indirect effects of sedimentation or altered water currnets. Open-pile type structures permit continued tidal flow over existing marsh, avoid potential sedimentation problems, and have less effect on existing water current patterns.

D. Channels, fills and structures should be designed to meet the special stresses of the marine environment and to also minimize the frequency of future maintenance activities.

RATIONALE: Shoreline alterations often change currents, affect shoreline stability and cause biological damage. Unsuccessful structures or channels generate demands for remedial action which can compound initial adverse effects. The lessening of frequency of dredging in channels is particularly important. Dredging destroys or displaces bottom-dwelling organisms of value to the aquatic food web. Organisms can be expected to recolonize a dredged area after a period of time however too frequent dredging can inhibit recolonization.

E. High density development in or immediately adjacent to wetlands and/or other flood plains should be discouraged.

RATIONALE: Low-lying development has historically created costly flood control and flood relief problems including claims for indemnification. Additionally, hydrological changes in upland surface run-off water are caused by the paving over of formerly absorbent soil, the usual effect being to increase both the amount amd the rate of surface water flow, thus causing shoreline erosion and other problems (Leopold, 1968). Finally, high-density development leads to a concentration of contaminating constituents in urban surface water runoff which can severly stress receiving waters in the adjacent marine environment (Burke, 1971). There seems to be a direct relationship between populations in a watershed and increased coliform levels in adjacent waters which can lead to long term restrictions in the direct marketing of shellfish (Wiley, 1974).

SPECIFIC GUIDELINES

The following specific guidelines are recommended for use in the design, evaluation or modification of individual projects.

A. Shoreline defense structures.

1. Shoreline defense structures are justified only if there is active detrimental shoreline erosion which cannot be otherwise controlled; if there is channel sedimentation injurious to marine life or impairing navigation which cannot be corrected by upland means; or if there is a clear and definite need to accrete beaches.

RATIONALE: The location and design of shoreline defense structures is a highly technical subject and often the precise effects of structures on littoral processes cannot be predicted. A study of one county's shoreline showed nearly 50% of the existing shoreline defense systems to be ineffective or poor in performance (Athearn et al., 1974). All defense structures damage the environment and unnecessary ones may cause greater problems than existed without them. Solution of an erosion problem requires knowledge of littoral processes in general plus a knowledge of specific processes of the location in question. This guideline also clearly precludes the construction of bulkheads for purely aesthetic reasons.

2. When bulkheads are deemed to be necessary, they should ordinarily be placed landward of any existing and productive marsh vegetation. A line of saltbushes, if existing, can usually indicate the seaward limit of a bulkhead.

RATIONALE: A bulkhead behind a marsh preserves the marsh for its biological productivity and utilizes the marsh's capabilities of aiding water quality and deterring erosion.

3. Subject to specific analysis of the site, its characteristics and problems, rock or riprap bulkheads and groins are generally preferred over vertical structures. Gabions may also be suitable. The term "rock or riprap" means carefully placed selected rock or concrete forms which are especially designed for the purpose (Thompson, et al., 1972). The term "gabion" refers to specially designed wire baskets which are filled with small rock, rubble or shells to give them necessary weight. Uncontained broken concrete pavement, cement blocks, and similar rubble are usually not acceptable due to their small size and light weight.

RATIONALE: Vertical bulkheads reflect energy and often merely transfer a problem elsewhere. Where wave energy problems exist, whether from natural causes or from boat wakes, riprap and gabions are more energy absorbent and have a longer life span than a vertical structure. In addition, the slope and nooks and crannies in riprap and gabion structures provide a more suitable habitat for crabs and small fish. In some cases, sediment is caught in riprap and gabion structures and is subsequently vegetated with marsh species.

B. Dredging and filling.

1. When filling a marsh is justified, the activity should be confined to the area inland of the wrack line or any existing saltbush line. If suitable non-marsh areas are not available and it is necessary to locate the fill further seaward, locations in Group 3-5 marshes should be selected if possible (reed grass, saltwort, saltbush, black needlerush, yellow pond lily). In any event, every effort should be made to preserve existing saltmarsh cordgrass (*Spartina alterniflora*), arrow arum (*Peltandra virginica*) or pickerel weed (*Pontederia cordata*).

RATIONALE: The values of the more important species are preserved thus somewhat lessening the undesirable impact of destroying marshes.

2. When it is found justified to dredge into a marsh, every effort should be made to select an area in Group 3-5 marshes (reed grass, saltwort, saltbush, black needlerush, yellow pond lily).

RATIONALE: The values of the more important species are preserved thus somewhat lessening the undesirable impact of destroying marshes.

3. Dredge spoil should not ordinarily be deposited in adjacent marsh as a convenience. If it becomes necessary to place spoil on a marsh, consideration should be given to piling on lower value portions of the marsh or to scattering the spoil in a

thin layer rather than containing the spoil behind a berm. Berms in marshes should be used to contain fill only when absolutely necessary and when they will not cut off tidal flow to wetlands areas.

RATIONALE: A continuous berm often cuts off water supply to a marsh. Selective piling allows continued water supply to uncovered portions of a marsh and may enhance habitat for wildfowl and animals. Scattering of spoil in a thin layer can sometimes maintain basic marsh values though it may ultimately lead to some change in vegetative species if the marsh surface is significantly raised in elevation. The depth of the soil layer must be evaluated in each case.

4. Whenever feasible, displaced marsh vegetation and peat should be used to reconstitute marsh in the vicinity of the activity site and particularly along the banks of newly cut canals.

RATIONALE: This procedure will aid to maintain the inventory of marshes and will deter shoreline erosion and enhance water quality conditions.

5. Overboard disposal of dredge spoil is generally undesirable unless the deposits are basically sand, free of pollutants, the spoil area is devoid of commercially important bottom organisms, and the deposits may have a beneficial effect on shoreline erosion problems. There may be occasions when overboard disposal of silty spoil can be used to create marsh however this will probably also entail the planting or seeding of marsh vegetation under closely controlled conditions.

RATIONALE: Silty soils tend to stay in the water column longer than the heavier sands and may drift to other areas causing damage to bottom organisms outside of the selected spoil area. Pollutants may likewise drift with the currents. In some cases, good quality sand can be beneficial in nourishing starved or eroding beaches and this possibility should be considered.

6. Fill material, whether on wetlands or nearby fastlands, should not contain contaminants which may leach into adjacent waters.

RATIONALE: Oil or other contaminants can leach off of the surface of filled areas and travel to adjacent waters via surface runoff. In some instances, they may also leach downward into the water table. In either case, water quality is impaired.

7. Dredging in or near wetlands for the single purpose of obtaining land fill is usually not justified.

RATIONALE: The potential adverse effects of dredging, all of which are not precisely known, do not warrant the risk when upland fill can serve the purpose. Dredging destroys, at least temporarily, organisms which are directly useful to man (shellfish) and other organisms, both plant and animal, which are part of the aquatic food web. The increased water depth after the dredging will eventually lead to a change in the existing biota, the effects of which are not well known.

8. Where feasible, dredging in fresh and near-fresh waters should be

restricted to the months of November through mid-March. In brackish and saline waters capable of sustaining oysters and clams, the better months for dredging are mid-March through June and in October and November. Where commercial dredging for crabs in deeper waters is an important factor, the better months for dredging are from April through November.

RATIONALE: These times for dredging lessen the possibility of interfering with important commercial fisheries. They avoid the periods of greatest vulnerability such as times of finfish spawning and migration, shellfish spawning and extremely cold periods when shellfish pumping activity is reduced by cold water temperatures.

C. Sediment Control.

1. Dredging of new channels into marshes or fastlands should be done "in the dry" if possible; that is, all excavating should be completed prior to connecting the new channel to an existing waterway. In existing waterways, sediment curtains should contain the area of dredging activity if practical.

RATIONALE: Dredging often suspends sediments which drift to other areas and threaten marine bottom organisms. The suggested procedures either reduce sediment problems or confine them to a localized area.

2. For relatively small projects (1000 yards or less), dredging by dragline is usually environmentally preferable to dredging by the hydraulic method.

RATIONALE: Control of sedimentation is much simpler with the dragline in that there is a higher ratio of soil to water as the spoil is transferred from the dredging area. Spoil areas created by dragline dredging can also be treated and vegetated more quickly than those resulting from hydraulic dredging. There are times, however, when hydraulic dredging is preferred, particularly when spoil is to be placed in an area remote from the dredge site.

3. Dredge spoil disposal areas should meet the criteria contained in Appendix 4 (pg. 81), VIMS SRAMSOE No., 35, Local Management of Wetlands - Environmental Considerations.

RATIONALE: The material contained in SRAMSOE No. 35 are in use in other areas and are proving effective in protecting water quality by reducing sediment loads to waters adjacent to spoil areas.

D. Channelling into fastlands or marshes.

1. Where feasible, community piers and launching facilities are preferable to channelling into fastlands or marshes for water access in conjunction with urban development.

RATIONALE: Studies have shown that such channelling leads to water quality problems (Barada and Partington, 1972; Trent et al., 1972). Poor water circulation and flushing, combined with contaminating constituents and high nutrient loads from adjacent development often lead to reduced dissolved oxygen levels, noxious odors, uncontrolled algal growth and fish kills.

2. Even though VIMS strongly objects to the practice, there may be times when canals through marshes or uplands are permitted. When this is the case, the following criteria should be applied:

   a. Channels should not be dead-ended but should be connected to a fastland drainage source which will allow a flow-through of water.

   b. Channels should be short in length and preferably no longer than twice the width.

   c. Channels should not be dredged more than 1 foot deeper than the depth of the waterway to which they are to be connected.

   d. Channels should not be box cut but should be dredged with slopes that approximate the natural angle of repose of soils of the area, usually on the order of 3 feet horizontal for every 1 foot vertical.

   e. The top banks of channels should be graded to a slight incline anywhere between mean sea level and mean high tide for an inland distance of at least 10 feet. This area should then be planted with marsh vegetation appropriate to the soils and the salinity of waters in the area.

RATIONALE: The foregoing criteria reduce the potential adverse impacts of channelization by providing for better water circulation and bank stability. The marsh vegetation aids in preventing upland spoils and contaminants from lowering water quality.

SECTION VI

WETLANDS RESEARCH

In order to more completely understand the function of a wetland system, researchers at VIMS are involved in wetland studies that incorporate the sciences of geological oceanography, chemistry and marine biology. The staff of the Wetlands Research Section is grateful for the input from our colleagues whose wide ranging expertise has enlarged our knowledge of wetland dynamics and other related problems. The following sections discuss marsh research and related studies completed or currently in progress. Many of these projects are applicable to wetland management problems.

A. Geology of Wetlands and Shoreline Processes.

1. Tidal Creek Flow and Suspended Solid Transport. Given the twice-daily flooding of marshes during spring tide conditions, coupled with average tidal periods, a large amount of water and energy is provided to transport materials to and from the interior of marsh systems. It appears that much of this exchange is localized within small channel networks. Studies of a marsh drainage system on the Eastern Shore of Virginia indicate that a definite irregularity in the rate of flow prevails during a complete tidal cycle. This asymmetry appears to result in a net movement of suspended material exported from the marshes over many tidal cycles (Boon, in press).

Seasonal effects have been observed in the system under study. These include a positive correlation between water temperatures and suspended sediment load levels and a seasonally related distribution of water volume magnitudes (tidal prisms) entering the marsh.

Levels of suspended sediment concentration are low in winter and high in the summer months. There is also a variation in tidal prism magnitudes, i.e., lower during January and February and higher during September and October.

It can be concluded therefore that active transport capacity of the marsh drainage system is enhanced during the late summer and early fall and diminished during the winter months. This pattern should be of interest to workers studying marsh transport processes and to those contemplating major excavation and/or fill projects adjacent to marshes.

2. Shore erosion in Tidewater Virginia. In this study, maps of the 1850 period were compared with the series of the 1940's with respect to shoreline position. The approximately 3,000 miles of shoreline were divided into about 1,750 segments for which erosion rates were calculated. The results indicate that over 20,000 acres of land have been eroded in the 100 year period of which 12,500 acres of that loss occurred on the shore of Chesapeake Bay proper. The report will be available for distribution in summer of 1974.

3. County Shoreline Situation Reports. The importance of comprehensive planning in the utilization of the resources of the coastal zone is gaining increased recognition throughout the Commonwealth. One central facet of such considerations is the characteristics of the shoreline, a limited resource.

Although planners frequently have a generalized idea of the importance of coastal processes much of the relevant information is generally not available in useful form.

Our goal is to supply the assessment, and at least a partial integration, of those important shoreline parameters and characteristics which will aid the planners and managers. We have given particular attention to shore erosion and approaches to correction. In addition we include uses of the shoreline, particularly with respect to recreational use since such information could influence the perception of the coast by potential users. Those characteristics included in the report are: shoreline physiographic use and ownership, classification, zoning, water quality, shore erosion, existing defenses and recommendations, potential shore uses, distribution of marshes, flood hazard levels, and shellfish leases and public grounds.

Reports will be prepared for each Tidewater county within the next two years.

4. Ocean Shoreline Studies. Recent VIMS studies indicate very high erosion rates on the barrier islands of the Eastern Shore. Although the erosion rates along the Virginia Beach-Sandbridge segment are smaller, dramatic shore management problems exist in the maintenance of the beach to satisfy recreational demands.

Wave refraction studies are underway which will specify where areas of wave energy concentration exist along the shoreline. This information has direct bearing on the planning of coastal defenses.

B. Chemistry of Wetlands.

1. Function of Marshes in Reducing Eutrophication of Estuaries of Virginia. Marshes function in a variety of ways in the estuarine systems. Some of these are buffering erosion, flood control and providing wildlife habitat. A more significant value, however, is their potential to provide organic matter in the form of detritus and their contributions to the estuarine nutrient budgets. This study involves the relationships between marsh productivity, detritus flux and nutrient flux of two wetland systems, a medium salinity marsh (Carter Creek, Gloucester County) and a low salinity marsh (Ware Creek, James City County).

Primary Production

This phase of the study was carried out in order to determine the annual productivity of two Virginia marshes, each in a different salinity regime, and to attempt to correlate the production with the following substratum nutrients: nitrogen, phosphorus, calcium, magnesium, potassium, pH and soil solution itself.

It was found that there were no significant correlations between production and soil nutrient concentrations in the marshes with the exception of a significant positive correlation between potassium and plant production in Ware Creek Marsh. The study also revealed that low salinity marshes tend to be more productive than high salinity marshes in Virginia.

Detritus Flux

Carter Creek and Ware Creek had different growing seasons. Ware

Creek, trending toward a freshwater system, began its growing season in early March with its peak of biological activity in July. By September, it was again at March levels. Carter Creek, the more saline system, began its growing season in May, peaked in August and did not decline until October.

Flux calculations indicated a net export throughout the year of "living material" from both marshes. Therefore, marshes apparently contribute both autotrophic (algae) and heterotrophic organisms (bacteria, copepods, amphipods) to the river. Much of this material probably consists of microorganisms associated with the particulate matter in the water. Also particulate organic carbon and dissolved organic carbon were found to exhibit net losses from both marshes during the late summer and fall periods.

Nutrient Flux

The high productivity of estuaries is largely dependent on the amount of nutrients in the water. Nitrogen and phosphorus, the two nutrients considered as limiting the primary productivity capability of estuaries, are present largely in their inorganic forms, nitrate and phosphate.

This phase of the study has shown that nutrient rich marsh sediments help maintain high phosphate concentrations in the estuary.

Information gained from this study also suggests that there is a significant amount of atmospheric nitrogen fixation by marsh plants that is exported from the marshes as nitrate. Nitrogen, in the form of ammonia and dissolved organic nitrogen, is also received by the estuary from marshes.

The saltmarsh ecosystem thus influences estuarine primary productivity by converting estuarine produced particulate organic nitrogen and phosphorus and exporting these nutrients in a dissolved form that can be assimilated by algae, one of the essential producers in the marine food web.

C. Biology of Marshes.

1. Effects of Oil Contamination on Marsh Biota. This project is designed to study the effects of chronic oil pollution on the fringing saltmarshes typical of Viriginia wetlands. During the two year course of data acquisition, parameters of biomass, productivity and community structure are being monitored in order to indicate both obvious and more subtle changes in the energetics of the stressed saltmarsh. Field work is presently underway and laboratory studies are scheduled to begin in the spring. The ultimate goal is to provide a basis for predicting the effects of facilities such as refineries and oil ports on Virginia's wetlands.

2. Marsh Grass Seed Germination and Seedling Success. The purpose of this study is to determine seed germination and seedling development potential from marsh grasses collected from Virginia's wetlands which can lead to eventual creation or reconstruction of wetlands.

Marsh grass seeds have been harvested from marshes of three distinct salinity regimes in the lower Chesapeake Bay.

Seeds from each of the various salinity regime marshes will be grown under controlled conditions in order to determine optimal germination and seedling success for each regime. Further experiments will determine the effects of salinity and substrate composition on germination and seedling growth.

In order to increase our knowledge concerning the use of marsh grasses as a deterrent to erosion, a study will be conducted comparing annual root and rhizome production in varying salinities and substrate types.

Seed germination and seedling success in perturbed systems will be studied as a part of this project. Using petroleum fractions, fertilizers and sewage materials as stressors, the germination success of various species of grass will be investigated. The goal is to indicate some of the effects of various types of chronic pollution frequently associated with marshes in Tidewater Virginia.

Phase II of this project will involve the raising of marsh grass in the greenhouse and the eventual transplanting of these to areas suitable for the establishment of marshes. Knowledge will be gained concerning establishment success and erosion deterrent potential.

3. Community Structure of Freshwater Marshes. The tidal freshwater marshes of the Pamunkey and the Mattaponi rivers represent one of the most extensive ecosystems of this type on the eastern seaboard of the United States. Here may be found as many as 59 different species of flowering plants in less than one acre. Largely because of the complexity of their vegetation and inhospitable conditions, the ecology of freshwater marshes is little known. In order to inventory and manage these marshes, it is necessary to systematically define the community types found there.

The Sweet Hall Marsh on the Pamunkey River will be the site for this study. This project is in its initial stages and will involve standard ecological methods of sampling and data gathering.

4. Growth Habits and Distribution of Reed Grass (*Phragmites australis*).

P. australis is considered to be a desirable species in the marshes of England and Europe. In these environs, it provides a habitat for many marsh animals including the marsh hawk.

In the freshwater marshes of the Paumunkey and Mattaponi rivers, however, it is deemed to be a pest as it competes with more desirable grasses such as wild rice (*Zizania aquatica*) and big cordgrass (*Spartina cynosuroides*). Reed grass frequently invades disturbed areas of a marsh, and often grows on dredge spoil. It seems particularly successful on sandy dredge spoil and because of its extensive network of roots and rhizomes, may be useful as a deterrent to erosion in this situation.

This study will attempt to determine the biological aspects of this grass that affect the ecology of marshes, particularly its role as a pioneer species in secondary marsh succession.

D. Other Research

Remote Sensing Techinques: Textural Signatures for Wetlands Vegetation.

The interpretation of remotely sensed data requires a significant amount of ground truth data. This is particularly complicated in the case of freshwater marsh vegetation where the plant communities are relatively complex and the terrain is inhospitable. Textural features can help provide the ground truth information necessary to accomplish vegetational mapping of marshes and can reduce the amount of ground truth data that must be gathered by traversing a marsh on foot. Texture is defined as the film density variations that are influenced by factors such as position of leaves, type of stock and position of individual plants with respect to each other and with respect to their background.

This project, a cooperative effort of NASA/Langley and VIMS, was undertaken with the ultimate aim of providing VIMS and similar organizations with another tool to aid in the task of defining the ecological significance of any wetland area.

Additional Research Needs

A. Shoreline Erosion Problems

Fringing marshes, especially those supporting Saltmarsh Cordgrass communities and other marsh grass, are known to deter erosion. However, questions still remain concerning the minimum width of marsh necessary to effectively buffer erosion.

Other factors, besides width, which need to be studied with respect to buffering capability are peat depth, nature of substratum and the effects of boat wakes.

Heavy boat traffic in marshlands and rivers usually accelerates the erosion rate of marsh edges. This is particularly true in freshwater marshes where the soft mud substratum and the less resilient cover vegetation is present. Studies are needed to determine if erosion can be abated in these areas by replacing the normal soft stemmed, broadleaved vegetation with more erosion resistent grasses, sedges and rushes.

Research is also neededto determine alternatives to present shoreline stablizing structures and construction practices. Questions should be answered concerning the effectiveness of integrated control of erosion employing native vegetation and gabions. Other research is needed to explore the compatability of vertical bulkheads and natural fringing marshes.

B. Effects of Channelization through Marsh and Uplands.

As more people seek waterfront homes, Venetian type housing developments and canals have become more prevalent. Complexes such as these have a deleterious effect on the receiving waters and marshes if they are not carefully planned. Some of the direct problems that researchers need to address themselves to are what are the effects on water quality of 1) the various channel depths employed 2) the normal pollutant runoff from canal-side residences 3) the septic tanks used by canal-side homes 4) various bank stablizing measures 5) canal length and design 6) various degrees of sediment control employed.

C. Marsh Creeks as Fish Spawning and Nursery Area.

In order to more adequately evaluate tidal marsh systems in Virginia, there is a definite need for an inventory of fish spawning and nursery grounds. Much of this information, such as species and numbers, is available from the Icthyology Department at VIMS.

However several needs are still outstanding that would be helpful in our marsh evaluation program, such as (1) the frequency that spawning and nursery grounds are associated with marshes (2) correlation of fish species and numbers with marsh types (3) periodic sampling (4) and ratio of water area to marsh area.

D. Marsh Succession.

Marshes are dynamic ecosystems. Wetlands undergo a constant process of erosion and accretion. Some marsh expansion in tidewater Virginia has been noted in a series of aerial photographs ranging in years from 1937 to 1971. A study is neededto determine the nature and effect of this type of recent marsh development.

Problems to be investigated would be (1) serial marsh succession (2) comparison of developing marshes in various stages of succession (3) physical processes involved in marsh formation (4) peat depth and age determination (5) nature of substratum.

Wetlands Inventory

As set forth in the Wetlands Act of 1972, the Virginia Institute of Marine Science is obligated to inventory the wetlands of tidewater Virginia in order to better access this resource. This program is planned as a series of marsh inventory reports of tidewater counties and cities. Two county reports, Lancaster and Mathews, have been published. The city of Hampton and York County and town of Poquoson inventory reports are scheduled to be published by August 1974. In these reports, individual marshes of 1/4 acre in size or larger are located and numbered in sequence on maps. Information such as individual marsh acreage, marsh vegetation percentage and acreage, and other information are recorded in tabular form. The reports are arranged primarily according to natural wetland systems organized into sections.

Northumberland, Westmoreland, King George and Stafford counties are scheduled to be inventoried during the summer and fall of 1974 if present staff personnel are utilized. If funds are available for additional staff in the inventory program, several other counties can be inventoried during this time.

GLOSSARY

ALGAE - Simple marine or freshwater phytosynthetic plants. May be single or multicelled.

AUTOTROPHIC - (Organism). Independent of outside sources of organic substances required for growth. Generally refers to green plants.

BENTHIC - Pertaining to any plant or animal living in or on the bottom sediment of a river, ocean, lake or other aquatic system.

BRACKISH - Pertaining to the waters of bays and estuaries, salty but of lower salinity than seawater.

BULKHEAD - A structure or partition, usually running parallel to the shoreline, for the purpose of protecting fastlands from wave action or protecting channels from upland sedimentation.

COMMUNITY - Ecological term for any naturally occurring group of different organisms inhabiting a common environment, interfacing with each other especially through food relationships, and relatively independent of other groups. Communities may vary in size and larger communities may contain smaller ones.

DETRITUS - Organic matter (primarily marsh plants) which while decaying in the aquatic system forms the basis of a major marine food web. The organic matter and its rich growth of microbes are fed on by many estuarine species.

DOMINANT - For purposes of classifying marshes in this report, any organism which makes up at least 50% by volume of the organisms present in a given area.

DRAGLINE - The method of dredging employing a crane and large metal bucket to remove accumulated sediment.

DREDGING -"IN THE DRY"- A technique of dredging used where new channels or canals are being cut. The canal is dredged from the landward end toward the seaward end and the last step is to open the new canal to the existing waterway.

DIKE	- A wall or mound built around a low-lying area to prevent flooding. Sometimes called a berm.
ECOLOGY	- The overall relationships between organisms and their environment.
ECOTONE	- The transition area between two adjacent communities.
EUTROPHICATION	- The natural process whereby nutrients increase in concentration in rivers, estuaries and other bodies of water. Man's influence has the effect of speeding up the natural process and causing problems in many cases.
FASTLANDS	- The zone extending from the landward limits of wetlands to at least 400 feet inland.
FRESH WATER	- Waters containing no appreciable salt, usually less than 0.05% or 0.5 parts per thousand.
FOOD WEB	- The complex interactions of organisms in a natural community involving organisms feeding on one another to obtain energy.
GABION	- A container filled with stone, brick, shells or other material to give it a heavy weight suitable for use in constructing bulkheads or groins. In the marine environment, usually made of galvanized steel wire mesh with a PVC (polyvinyl chloride) coating over the galvanizing.
GROIN	- A shore protection structure built (usually perpendicular to the shoreline) to trap sand and other material moving along the shoreline and thus retard erosion of the shore.
HETEROGENEOUS	- Being composed of many different forms of something. Specifically, a heterogeneous marsh is one composed of many different plant species without any one being dominant.
HYDROLOGICAL	- Pertaining to water, its properties and distribution especially with reference to water on the surface of the land, in the soil and underlying rock.
INTERTIDAL	- Area on a shoreline between mean high water and mean low water.

JETTY - On open seacoasts, a structure extending into a body of water designed to prevent shoaling of a channel by sand or other materials. Usually placed alongside channels at entrances.

LINE OF SALTBUSHES - Refers to the characteristic growth of saltbushes. at the upper limit of the highest high tides. When present in a line along the inland side of a marsh it often denotes the upper limits of wetlands as defined in the Virginia Wetlands Act.

LITTORAL PROCESSES - Those physical features and characteristics of the intertidal area which determine the type of shoreline present.

MICROCOSM - A small community regarded as having all the characteristics of the biosphere or the world.

MONOSPECIFIC - Being composed entirely of one species or one type of organism. In this case a marsh vegetated by one type of grass.

MEAN HIGH WATER - The average height of high waters over a nineteen year period.

MEAN LOW WATER - The average height of low waters over a nineteen year period.

NITROGEN FIXATION - Conversion of atmospheric nitrogen into nitrogen compounds which can be more readily utilized by living organisms.

PERENNIAL - A plant which produces new growth year after year according to the seasons. In the case of nonwoody plants the aerial portion dies each winter and is replaced each spring.

PHYSIOGRAPHIC - A description of nature or natural phenomena in general.

POPULATION - All of the members of one species within a community.

PRODUCTIVITY - The rate of energy storage of an ecosystem or community in the form of organic substances which can be used as food materials.

RHIZOMES - Underground stems capable of producing new aerial shoots.

RIPRAP - Refers to a bulkhead or groin constructed of selected rock or concrete forms carefully placed so as to dissipate wave energy (bulkhead) or collect sand (groin) along a shoreline.

SHORE DEFENSE STRUCTURES - A bulkhead or groin intended to deter erosion of the shoreline.

SPECIATION - Pertaining to the numbers of different species inhabiting a given area, i.e. high speciation would mean many different species in one area.

SPOIL - The material removed from a channel bottom or other body of water during a dredging operation.

SPRING TIDES - Higher high tides which occur twice monthly due to astronomical conditions.

WRACK LINE - A line of debris, above the mean high tide line, which has been deposited by previous higher than normal tides.

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